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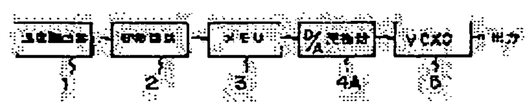
(54) DIGITALLY CONTROLLED TEMPERATURE COMPENSATION CRYSTAL OSCILLATOR

(57)Abstract:
PURPOSE: To provide the digital controlled temperature compensation crystal oscillator in which the allowable deviation in the frequency temperature characteristic is minimized.
CONSTITUTION: Temperature information detected by a temperature detector 1 is converted into address data and read address designation of a memory 3 storing temperature compensation data set to minimize the frequency deviation in the frequency temperature characteristic is implemented by converted address data, the temperature compensation data read from the memory 3 are converted into a temperature compensation voltage by a D/A converter 4A and the oscillating frequency of the voltage controlled crystal oscillator 5 is controlled by the converted temperature compensation voltage. In the digital controlled temperature compensation crystal oscillator 5, the conversion characteristic of the D/A converter 4A is set to the conversion characteristic in which the oscillating frequency of the voltage controlled crystal oscillator is changed linearly with respect to the temperature compensation data.



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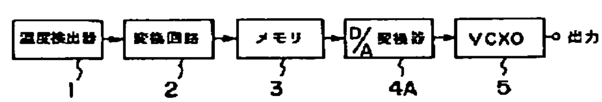
(54)【発明の名称】　デジタル制御形温度補償水晶発振器

(57)【要約】

【目的】　周波数温度特性の許容偏差を最小にしたデジタル制御形温度補償水晶発振器を提供すること。

【構成】　温度検出器1によって検出した温度情報がアドレスデータに変換され、周波数温度特性において周波数偏差が最小になるように設定された温度補償データが格納されたメモリ3の読み出しアドレス指定が変換されたアドレスデータによって行われ、メモリから読み出された温度補償データがD／A変換器によって温度補償電圧に変換され、変換された温度補償電圧によって電圧制御水晶発振器の発振周波数が制御されるデジタル制御形温度補償水晶発振器において、D／A変換器4Aの変換特性を電圧制御水晶発振器の発振周波数が温度補償データに対してリニアに変化する変換特性に設定した。



【特許請求の範囲】

【請求項１】　温度情報を検出する温度検出手段と、検出された温度情報をアドレスデータに変換する変換手段と、周波数温度特性において周波数偏差が最小になるように設定された温度補償データが格納されかつ変換手段からの出力アドレスデータによって読み出しアドレス指定されるメモリと、メモリから読み出された温度補償データを温度補償電圧に変換するＤ／Ａ変換器と、Ｄ／Ａ変換器によって変換された温度補償電圧が発振周波数制御電圧として印加される電圧制御水晶発振器とからなるデジタル制御形温度補償水晶発振器において、Ｄ／Ａ変換器の変換特性を電圧制御水晶発振器の発振周波数が温度補償データに対してリニアに変化する変換特性に設定したことを特徴とするデジタル制御形温度補償水晶発振器。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は周波数温度特性を改善したデジタル制御形温度補償水晶発振器に関する。

【０００２】

【従来の技術】従来のデジタル制御形温度補償水晶発振器は図５に示すように、温度検出器１の温度検出出力を変換回路２によってアドレスデータに変換し、変換回路２からの出力アドレスデータによって、温度補償データを格納したＲＯＭ等のメモリ３の読み出しアドレス指定を変換回路２からの出力アドレスデータによって行い、メモリ３から温度補償データを読み出して、読み出した温度補償データをＤ／Ａ変換器４によってアナログ電圧に変換し、変換アナログ電圧を温度補償電圧（発振周波数制御電圧）として電圧制御水晶発振器５に印加し、電圧制御水晶発振器５の発振周波数の温度補償を行っている。

【０００３】

【発明が解決しようとする課題】通常、変換回路２の出力は検出温度に比例しており、かつ精度良く温度補正するためにメモリ３に格納されている温度補償データは温度補償後のデジタル制御形温度補償水晶発振器の周波数温度特性が最適、すなわち周波数偏差が最小になるよう決定されており、温度に対応したアドレスに格納されている。一方、Ｄ／Ａ変換器は直線性が重要とされ、従来においては直線性の良いＤ／Ａ変換器が用いられている。

【０００４】しかし、その後段の電圧制御水晶発振器５の特性は一般に非線形であり、Ｄ／Ａ変換器の温度補償データ対周波数の関係も図６の一点鎖線に示すように非線形である。すなわち、図６に示すように温度補償データが小さい部分ａでは温度補償データがＬＳＢで〃１〃変わる毎の周波数変化量は大きく、温度補償データが大きい部分ｂではＬＳＢで〃１〃変わる毎の周波数変化量は小さい。これは電圧制御水晶発振器５内の可変容量ダイオード５１の電圧対静電容量特性が図７に示すように非線形であること、また水晶振動子５２の負荷容量対発振周波数特性が図８に示すように非線形であることから生ずる。

【０００５】一般に電圧制御水晶発振器に用いられる水晶振動子５２はＡＴカットが多く、温度範囲を広くとるためカット角を変えて補償周波数の範囲を大きくとるのが普通である。例えば図９に示す一般化した周波数温度特性の斜線部が用いられる。

【０００６】このような温度特性を持つ水晶振動子５２を補償するためには、広い制御範囲が必要であり、電圧制御水晶発振器の温度補償電圧の高低差も大きくなり、電圧制御水晶発振器の非直線性から温度補償電圧の高い電圧と低い電圧とでは温度補償データがＬＳＢで〃１〃変わる毎の周波数変化が異なることになる。

【０００７】この１例は図１０に示す如くである。温度補償電圧が一定の場合の周波数温度特性は図１０（ａ）に示す如くであって、これを補償するために温度に対応させた最適の温度補償データによって図１０（ｂ）に示す如く図１０（ａ）の特性と逆の特性を形成して温度補償する場合、メモリ３からの温度補償データを変換特性がリニアなＤ／Ａ変換器でＤ／Ａ変換した温度補償電圧で補正される。このとき図６の一点鎖線からも判るように、温度補償電圧の低いところでは周波数はａだけ変化し、高いところでは周波数ｂだけ変化することになり、この結果デジタル制御形温度補水晶発振器の許容周波数偏差は図１０（ｃ）に示すように最大で図６の周波数の変化ａに対応して周波数ａとなり、最小で図６の周波数の変化に対応して周波数ｂとなって、最大偏差は周波数ａによって許容周波数偏差が決まってしまうという問題点があった。

【０００８】本発明は周波数温度特性の許容偏差を最小にしたデジタル制御形温度補償水晶発振器を提供することを目的とする。

【０００９】

【課題を解決するための手段】本発明のデジタル制御形温度補償水晶発振器は、温度情報を検出する温度検出手段と、検出された温度情報をアドレスデータに変換する変換手段と、周波数温度特性において周波数偏差が最小になるように設定された温度補償データが格納されかつ変換手段からの出力アドレスデータによってアドレス指定されるメモリと、メモリから読み出された温度補償データを温度補償電圧に変換するＤ／Ａ変換器と、Ｄ／Ａ変換器によって変換された温度補償電圧が発振周波数制御電圧として印加される電圧制御水晶発振器とからなるデジタル制御形温度補償水晶発振器において、Ｄ／Ａ変換器の変換特性を電圧制御水晶発振器の発振周波数が温度補償データに対してリニアに変化する変換特性に設定したことを特徴とする。

【００１０】

【作用】本発明のデジタル制御形温度補償水晶発振器によれば、Ｄ／Ａ変換器の変換特性は電圧制御水晶発振器の発振周波数が温度補償データに対してリニアに変化するために、温度補償データがＬＳＢで〃１〃変化したときに対する周波数変化が補償電圧の高低にかかわらず一定となり、周波数温度特性の許容範囲が小さくなる。

【００１１】

【実施例】以下本発明を実施例により説明する。図１は本発明の一実施例の構成を示すブロック図である。本実施例のデジタル制御形温度補償水晶発振器は、温度検出器１の温度検出出力を変換回路２によってアドレスデータに変換し、変換回路２で変換したアドレスデータによって、温度補償データを格納したメモリ３のアドレス指定を行い、メモリ３から温度補償データを読み出して、読み出した温度補償データをＤ／Ａ変換器４Ａによってアナログ電圧に変換し、変換アナログ電圧を温度補償電圧として電圧制御水晶発振器５に印加し、電圧制御水晶発振器５の発振周波数の温度補償を行うように構成してある。

【００１２】Ｄ／Ａ変換器４Ａの変換特性は後段の電圧制御水晶発振器５の周波数温度特性が考慮して、電圧制御水晶発振器５の発振周波数がメモリ３から出力される温度補償データに対してリニアに変化するように構成してある。ここで、精度良く温度補正するためにメモリ３に格納されている温度補償データは温度補償後のデジタル制御形温度補償水晶発振器の周波数温度特性が最適、すなわち周波数偏差が最小になるよう決定されており、温度に対応したアドレスに格納されていることは前記のとおりである。

【００１３】例えばＤ／Ａ変換器４Ａは、図２に示すように１６ビットの場合で例示すれば、直列接続された抵抗R_1～R_{16}と、メモリ３からの４ビットの温度補償データを１６ビットにデコードするデコーダＤと、一端が共通接続され、かつ多端が抵抗R_1～R_{16}の一端にそれぞれ各別に接続されてデコーダＤのデコード出力でオンオフが各別に制御されるスイッチS_1～S_{16}と、スイッチS_1～S_{16}の共通接続点の電圧を増幅するボルテージフォロワＡとからなる抵抗分割方式のＤ／Ａ変換器で構成してあって、後段の電圧制御水晶発振器５の周波数温度特性を考慮して、電圧制御水晶発振器５の発振周波数がメモリ３から出力されるデータに対してリニアに変化するように抵抗R_1～R_{16}の抵抗値がそれぞれ設定してある。

【００１４】上記のように構成した本実施例のデジタル制御形温度補償水晶発振器は、温度検出器１の温度検出出力はアドレス変換回路２によってアドレスデータに変換され、このアドレスデータによって温度補償データを格納したメモリ３のアドレス指定がされ、メモリ３から温度補償データが読み出されて、読み出された温度補償データがＤ／Ａ変換器４Ａによってアナログ電圧に変換される。

【００１５】この変換されたアナログ電圧が温度補償電圧として電圧制御水晶発振器５に印加される。しかるに、Ｄ／Ａ変換器４Ａは電圧制御水晶発振器５の周波数温度特性が考慮されて、電圧制御水晶発振器５の発振周波数がメモリ３から出力される温度補償データに対してリニアに変化するように構成されているため、電圧制御水晶発振器５の発振周波数はメモリ３から出力される温度補償データに対してリニアに変化する。

【００１６】この結果、Ｄ／Ａ変換器４Ａを用いたとき温度補償データ対周波数特性は図６において直線で示す如く、温度補償データ対周波数の特性は直線となる。そこで、温度補償電圧が一定の場合の周波数温度特性は図３（ａ）に示す如く、図１０（ａ）に示す周波数温度特性と同一の特性に対して、これを補償するために温度に対応させた最適の温度補償データに設定することによって図３（ｂ）に示す如く図３（ａ）の特性と逆の特性を形成して温度補償した場合、温度補償電圧の低いところで温度補償データがＬＳＢで〃１〃だけ変化したとき周波数はｃだけ変化し、高いところでも周波数ｃだけ変化することになり、この結果デジタル制御形温度補水晶発振器の許容周波数偏差は図３（ｃ）に示すように最大および最小で周波数ｃとなって、図１０に示す場合よりも小さくなる。

【００１７】次に本発明の他の実施例に付いて説明する。図４は本発明の他の実施例の構成を示すブロック図である。本他の実施例においては、図５に示した従来例の構成においてＤ／Ａ変換器４と電圧制御発振器５との間に、折線近似で図６において破線で示すように、図６の一点鎖線で示す特性を打ち消しＤ／Ａ変換器４を含み、デジタル制御形温度補償水晶発振器の周波数温度特性が直線となる特性に構成した等化器６を挿入して、Ｄ／Ａ変換されたアナログ信号を等化器６によって非線形変換し、周波数制御電圧として電圧制御発振器５に印加する。

【００１８】したがって、本他の実施例の場合においても、等化器６にとって電圧制御水晶発振器５の発振周波数がメモリ３から出力される温度補償データに対してリニアに変化するように構成されているため、前記一実施例の場合と同様に温度補償データを温度に対応させた最適の温度補償データに設定することによって、図３（ｂ）に示す如く図３（ａ）の特性と逆の特性を形成して温度補償した場合、温度補償電圧の低いところで温度補償データがＬＳＢで〃１〃だけ変化したとき周波数はｃだけ変化し、高いところでも周波数ｃだけ変化することになり、この結果デジタル制御形温度補水晶発振器の許容周波数偏差は図３（ｃ）に示すように最大および最小で周波数ｃとなって、図１０に示す場合よりも小さくなる。

【００１９】

【発明の効果】以上説明した如く本発明によれば、D／A変換器の変換特性を電圧制御水晶発振器の発振周波数が温度補償データに対してリニアに変化する変換特性に設定したために、温度補償データがＬＳＢで〃１〃変化したときに対する周波数変化が補償電圧の高低にかかわらず一定となって、周波数温度特性の許容範囲が小さくなる効果がある。したがってさらに、温度補償精度を高めるためにはD／A変換器のビット数を増加させることによって対応することができる効果がある。

【図面の簡単な説明】

【図１】本発明の一実施例の構成を示すブロック図である。

【図２】本発明の一実施例におけるD／A変換器の構成を示すブロック図である。

【図３】本発明の一実施例の作用の説明に供する模式特性図である。

【図４】本発明の他の実施例の構成を示すブロック図である。

【図５】従来例の構成を示すブロック図である。

【図６】D／Aの変換特性図である。

【図７】電圧対可変容量ダイオードの特性図である。

【図８】水晶振動子の負荷容量対発振周波数特性図である。

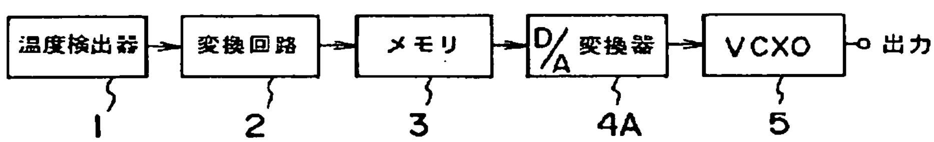
【図９】カット角をパラメータとするＡＴカット水晶振動子の周波数温度特性図である。

【図１０】従来例の作用の説明に供する模式特性図である。

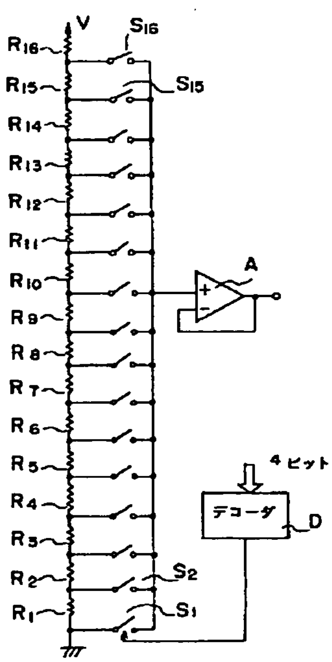
【符号の説明】

１　温度検出器
２　変換回路
３　メモリ
４Ａ　D／A変換器
５　電圧制御水晶発振器
６　等化器

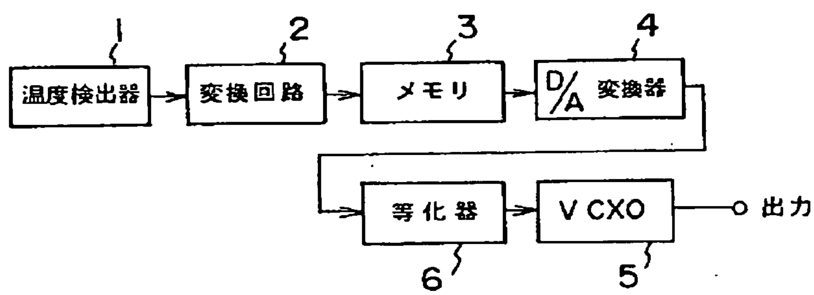
【図１】



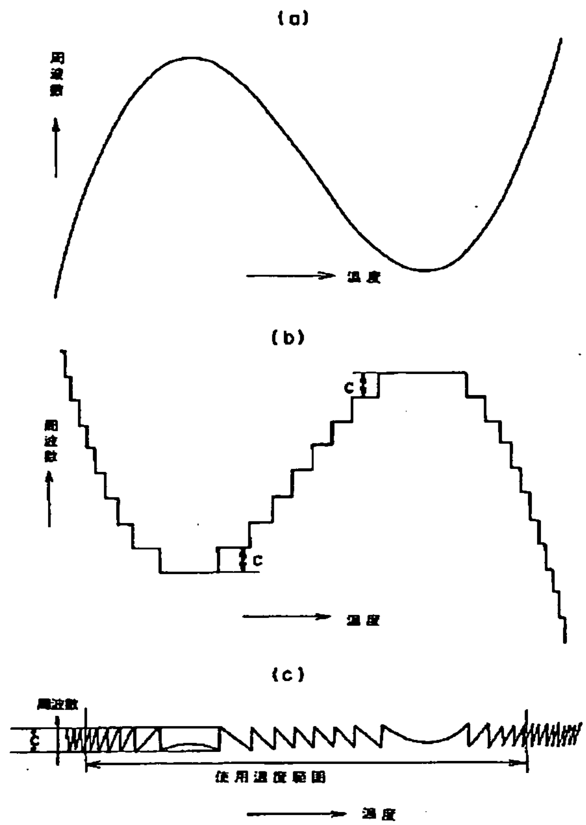
【図２】



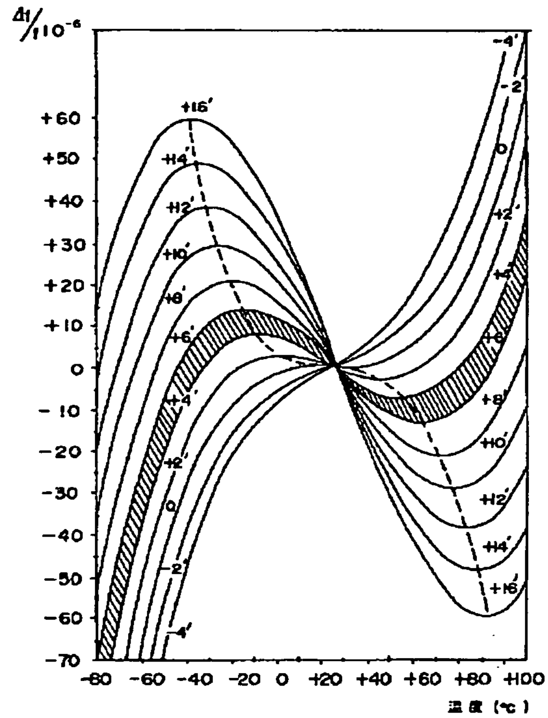
【図４】



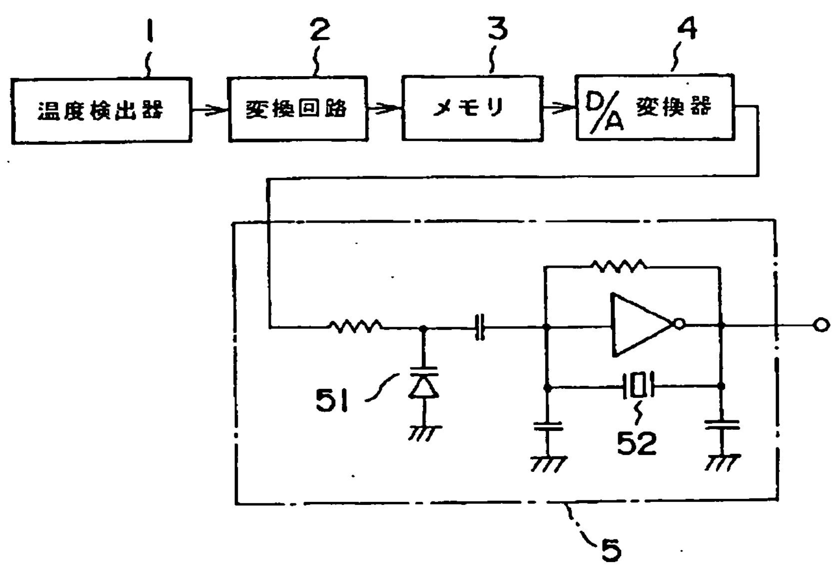
【図3】


(a)
周波数
温度
(b)
周波数
c
c
温度
(c)
周波数
c
使用温度範囲
温度

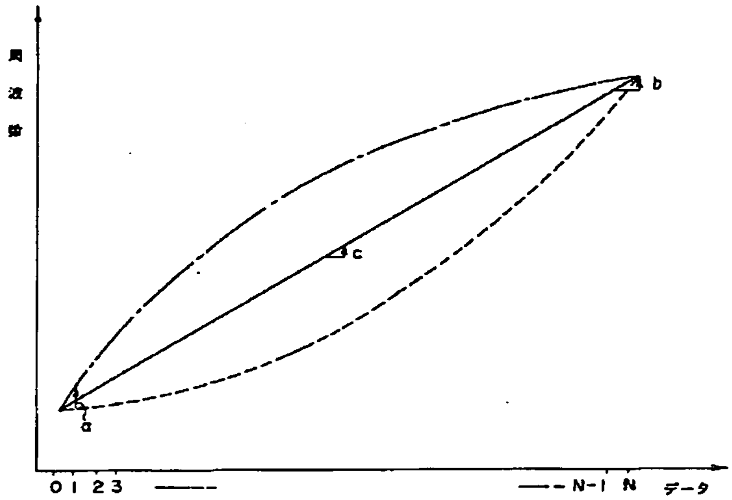
【図9】


Δf/f 10⁻⁶
+60
+50
+40
+30
+20
+10
0
-10
-20
-30
-40
-50
-60
-70
-80 -60 -40 -20 0 +20 +40 +60 +80 +100
温度（℃）

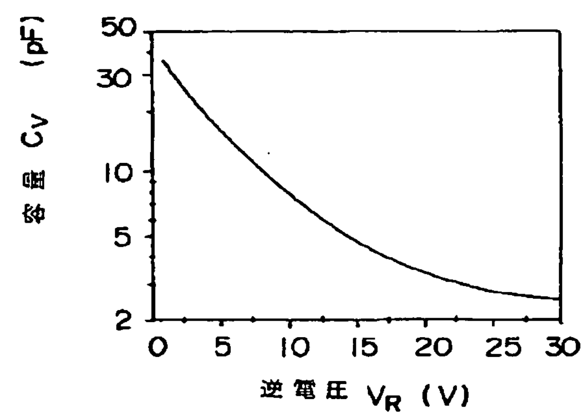
【図5】


1
2
3
4
温度検出器
変換回路
メモリ
D/A 変換器
51
52
5

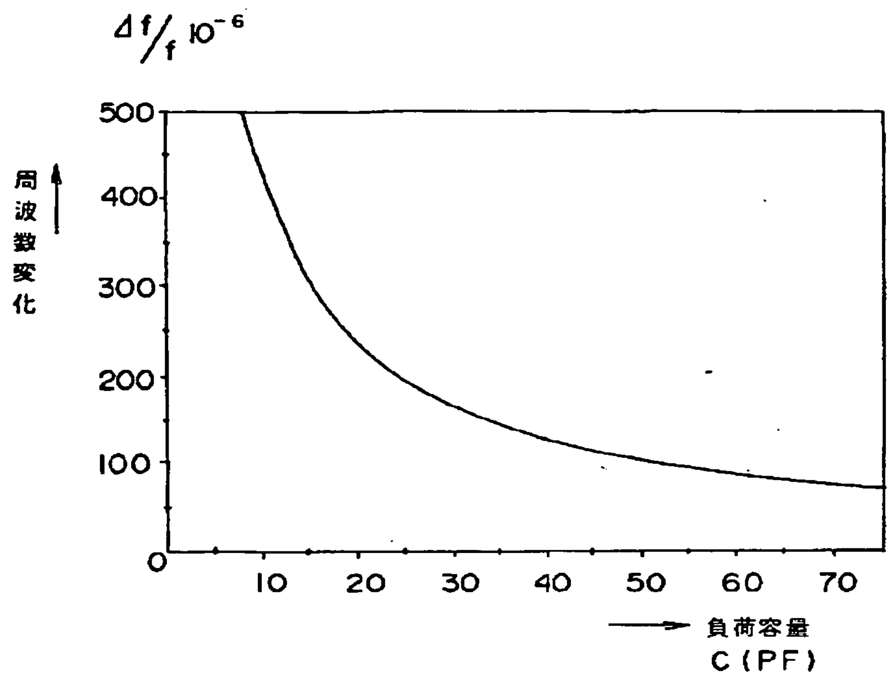
【図6】



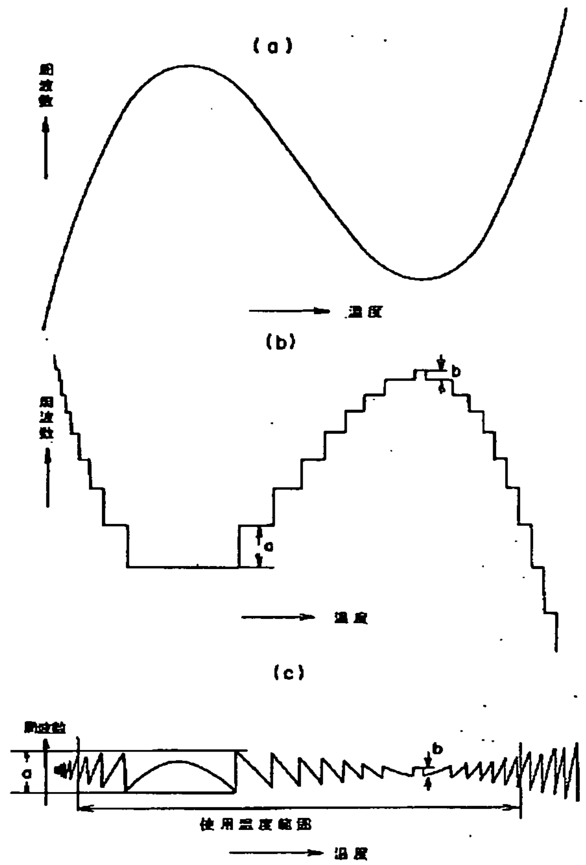
【図7】



【図8】



【図１０】



PATENT ABSTRACTS OF JAPAN

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(71)Applicant : KENWOOD CORP

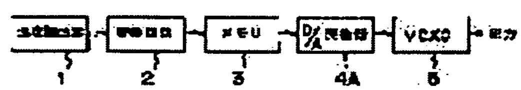
(72)Inventor : ONISHI MASA

(54) DIGITALLY CONTROLLED TEMPERATURE COMPENSATION CRYSTAL OSCILLATOR

(57)Abstract:

PURPOSE: To provide the digital controlled temperature compensation crystal oscillator in which the allowable deviation in the frequency temperature characteristic is minimized.

CONSTITUTION: Temperature information detected by a temperature detector 1 is converted into address data and read address designation of a memory 3 storing temperature compensation data set to minimize the frequency deviation in the frequency temperature characteristic is implemented by converted address data, the temperature compensation data read from the memory 3 are converted into a temperature compensation voltage by a D/A converter 4A and the oscillating frequency of the voltage controlled crystal oscillator 5 is controlled by the converted temperature compensation voltage. In the digital controlled temperature compensation crystal oscillator 5, the conversion characteristic of the D/A converter 4A is set to the conversion characteristic in which the oscillating frequency of the voltage controlled crystal oscillator is changed linearly with respect to the temperature compensation data.



LEGAL STATUS

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[Date of sending the examiner's decision of rejection]	11.11.1997
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]
[Claim 1] A temperature detection means to detect temperature information, and a conversion means to change the detected temperature information into address data, The memory which the temperature compensation data set up so that a frequency deviation might become min in the frequency temperature characteristic are stored, and is read and addressed with the output address data from a conversion means, The D/A converter which changes into a temperature compensation electrical potential difference the temperature compensation data read from memory, In the digital control form temperature compensated crystal oscillator with which the temperature compensation electrical potential difference changed by the D/A converter consists of a voltage controlled oscillator impressed as an oscillation frequency-control electrical potential difference The digital control form temperature compensated crystal oscillator characterized by setting the transfer characteristic of a D/A converter as the transfer characteristic from which the oscillation frequency of a voltage controlled oscillator changes to a linear to temperature compensation data.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the digital control form temperature compensated crystal oscillator which has improved the frequency temperature characteristic.
[0002]
[Description of the Prior Art] The conventional digital control form temperature compensated crystal oscillator changes the temperature detection output of a thermometric element 1 into address data by the conversion circuit 2, as shown in drawing 5 . With the output address data from a conversion circuit 2 The output address data from a conversion circuit 2 perform read-out addressing of the memory 3, such as ROM which stored temperature compensation data, and temperature compensation data are read from memory 3. The read temperature compensation data are changed into analog voltage with D/A converter 4, it is impressed by the voltage controlled oscillator 5 by making conversion analog voltage into a temperature compensation electrical potential difference (oscillation frequency control electrical potential difference), and the temperature compensation of the oscillation frequency of a voltage controlled oscillator 5 is performed.
[0003]
[Problem(s) to be Solved by the Invention] Usually, the output of a conversion circuit 2 is proportional to detection temperature, and in order that precision may improve temperature compensation, the temperature compensation data stored in memory 3 are determined that the optimal [the frequency temperature characteristic of the digital control form temperature compensated crystal oscillator after a temperature compensation], i.e., frequency deviation, will become min, and it is stored in the address corresponding to temperature. On the other hand, it is supposed that linearity is important for a D/A converter, and the D/A converter with sufficient linearity is used in the former.
[0004] However, generally the property of the voltage controlled oscillator 5 of the latter part is nonlinear, and as the relation of the temperature compensation data pair frequency of a D/A converter is also shown in the alternate long and short dash line of drawing 6 , it is nonlinear. That is, as shown in drawing 6 , the frequency variation of ** which **1** Changes temperature compensation data by LSB in the part a with small temperature compensation data is large, and the frequency variation of ** which **1** Changes temperature compensation data by LSB in the large part b is small. This is produced from a thing nonlinear as the electrical-potential-difference pair electrostatic-capacity property of the variable capacitance diode 51 in a voltage controlled oscillator 5 shows drawing 7 , and a thing nonlinear as the load-carrying capacity pair oscillation frequency characteristics of a quartz resonator 52 show drawing 8 .
[0005] There are many AT cuts, and in order that the quartz resonator 52 generally used for a voltage controlled oscillator may take a large temperature requirement, it is common to change a cut angle and to take the large range of a compensation frequency. For example, the slash section of the accepted frequency temperature characteristic shown in drawing 9 is used.
[0006] In order to compensate the quartz resonator 52 with such the temperature characteristic, a large control range will be required, the difference of elevation of the temperature-compensation electrical potential difference of a voltage controlled oscillator will also become large, and frequency change of ** which **1** Changes temperature-compensation data by LSB will differ from the nonlinearity of a voltage controlled oscillator on an electrical potential difference with a high temperature-compensation electrical potential difference, and a low electrical potential difference.
[0007] It seems that this one example is shown in drawing 10 . The frequency temperature characteristic when a temperature-compensation electrical potential difference is fixed is amended on the temperature-compensation electrical potential difference to which the transfer characteristic carried out D/A conversion of the temperature-compensation data from memory 3 with the linear D/A converter, when forming and carrying out temperature compensation of the property contrary to the property of drawing 10 (a) as the optimal temperature-compensation data made to correspond to temperature show to drawing 10 (b) in order to compensate this, as shown in drawing 10 (a). In the low place of a temperature-compensation electrical potential difference, as for a frequency, only a changes so that the alternate long and short dash line of drawing 6 may also show at this time. Only a frequency b will change in a high place, and as a result, the allowable frequency deviation of a digital control form temperature assistant crystal oscillator serves as a frequency a at the maximum corresponding to the change a of the frequency of drawing 6 , as shown in drawing 10 (c). Becoming a frequency b by min corresponding to change of the frequency of drawing 6 , muximum departure had the trouble that allowable frequency deviation will be decided by the frequency a.
[0008] This invention aims at offering the digital control form temperature compensated crystal oscillator which made allowable deviation of the frequency temperature characteristic min.
[0009]
[Means for Solving the Problem] The digital control form temperature compensated crystal oscillator of this invention A temperature detection means to detect temperature information, and a conversion means to change the detected temperature information into address data, The memory which the temperature compensation data set up so that a frequency deviation might become min in the frequency temperature characteristic are stored, and is addressed with the output address data from a conversion means, The D/A converter which changes into a temperature compensation electrical potential difference the temperature compensation data read from memory, In the digital control form temperature compensated crystal oscillator with which the temperature compensation electrical potential difference changed by the D/A converter consists of a voltage controlled oscillator impressed as an oscillation frequency-control electrical potential difference It is characterized by setting the transfer characteristic of a D/A converter as the transfer characteristic from which the oscillation frequency of a voltage controlled oscillator changes to a linear to temperature compensation data.

[0010]
[Function] According to the digital control form temperature compensated crystal oscillator of this invention, irrespective of the height of a compensation electrical potential difference becomes fixed [the transfer characteristic of a D/A converter / frequency change of], when temperature compensation data do **1** change of by LSB, in order that the oscillation frequency of a voltage controlled oscillator may change to a linear to temperature compensation data, and the tolerance of the frequency temperature characteristic becomes small.
[0011]
[Example] An example explains this invention below. Drawing 1 is the block diagram showing the configuration of one example of this invention. The digital control form temperature compensated crystal oscillator of this example With the address data which changed the temperature detection output of a thermometric element 1 into address data, and changed it by the conversion circuit 2 by the conversion circuit 2 Address memory 3 which stored temperature compensation data, and temperature compensation data are read from memory 3. The read temperature compensation data are changed into analog voltage by D/A-converter 4A, and it is impressed by the voltage controlled oscillator 5 by making conversion analog voltage into a temperature compensation electrical potential difference, and it constitutes so that the temperature compensation of the oscillation frequency of a voltage controlled oscillator 5 may be performed.
[0012] The frequency temperature characteristic of the latter voltage controlled oscillator 5 takes into consideration the transfer characteristic of D/A-converter 4A, and it is constituted so that it may change to a linear to the temperature compensation data with which the oscillation frequency of a voltage controlled oscillator 5 is outputted from memory 3. In order that precision may improve temperature compensation here, the temperature compensation data stored in memory 3 are determined that the optimal [the frequency temperature characteristic of the digital control form temperature compensated crystal oscillator after a temperature compensation], i.e., frequency deviation, will become min, and being stored in the address corresponding to temperature is as aforementioned.
[0013] For example, if D/A-converter 4A is illustrated by the case of 16 bits as shown in drawing 2 The resistance R1-R16 by which the series connection was carried out, and the decoder D which decodes the 4-bit temperature compensation data from memory 3 to 16 bits The switches S1-S16 with which common connection of the end is made, and many items are connected to the end of resistance R1-R16 at each **, respectively, and turning on and off is controlled by the decoding output of Decoder D by each **, Constitute from a D/A converter of the resistance division method which consists of a voltage follower A which amplifies the electrical potential difference of the common node of switches S1-S16, and the frequency temperature characteristic of the latter voltage controlled oscillator 5 is taken into consideration. The resistance of resistance R1-R16 is set up, respectively so that it may change to a linear to the data with which the oscillation frequency of a voltage controlled oscillator 5 is outputted from memory 3.
[0014] Addressing of the memory 3 in which the temperature detection output of a thermometric element 1 was changed into address data by the address translation circuit 2, and the digital control form temperature compensated crystal oscillator of this example constituted as mentioned above stored temperature compensation data with these address data is carried out, temperature compensation data are read and the read temperature compensation data are changed into analog voltage from memory 3 by D/A-converter 4A.
[0015] This changed analog voltage is impressed to a voltage controlled oscillator 5 as a temperature-compensation electrical potential difference. However, since it is constituted so that D/A-converter 4A may change to a linear to the temperature compensation data with which the frequency temperature characteristic of a voltage controlled oscillator 5 is taken into consideration, and the oscillation frequency of a voltage controlled oscillator 5 is outputted from memory 3, the oscillation frequency of a voltage controlled oscillator 5 changes to a linear to the temperature compensation data outputted from memory 3.
[0016] Consequently, when D/A-converter 4A is used, as temperature compensation data pair frequency characteristics are shown in a straight line in drawing 6 , the property of a temperature compensation data pair frequency serves as a straight line. Then, the property same as the frequency temperature characteristic when a temperature-compensation electrical potential difference is fixed is shown in drawing 3 R> 3 (a) as the frequency temperature characteristic shown in drawing 10 (a) is received. As by setting it as the optimal temperature compensation data made to correspond to temperature in order to compensate this shows to drawing 3 (b), when the temperature compensation of the property contrary to the property of drawing 3 (a) is formed and carried out, When temperature compensation data change at LSB only in **1**, as for a frequency, only c changes in the low place of a temperature compensation electrical potential difference. Even place [high], only a frequency c will change, as a result, the allowable frequency deviation of a digital control form temperature assistant crystal oscillator serves as a frequency c by max and min, as shown in drawing 3 (c), and it becomes smaller than the case where it is shown in drawing 10 .
[0017] Next, it attaches and explains to other examples of this invention. Drawing 4 is the block diagram showing the configuration of other examples of this invention. In the configuration of the conventional example shown in drawing 5 in the example besides a book between D/A converter 4 and a voltage controlled oscillator 5 As a broken line shows drawing 6 by broken line approximation, the equalizer 6 constituted in the property that negate the property shown with the alternate long and short dash line of drawing 6 , and the frequency temperature characteristic of a digital control form temperature compensated crystal oscillator serves as a straight line including D/A converter 4 is inserted. With an equalizer 6, nonlinear conversion of the analog signal by which D/A conversion was carried out is carried out, and it is impressed to a voltage controlled oscillator 5 as a frequency control electrical potential difference.
[0018] Therefore, since it is constituted so that it may change to a linear to the temperature compensation data with which the oscillation frequency of a voltage controlled oscillator 5 is outputted from memory 3 for an equalizer 6 in the case of an example besides a book, By setting it as the optimal temperature compensation data which made temperature compensation data correspond to temperature like the case of said one example As shown in drawing 3 (b), when temperature compensation of the property contrary to the property of drawing 3 (a) is formed and carried out, When temperature compensation data change at LSB only in **1**, as for a frequency, only c changes in the low place of a temperature compensation electrical potential difference. Even place [high], only a frequency c will change, as a result, the allowable frequency deviation of a digital control form temperature assistant crystal oscillator serves as a frequency c by max and min, as shown in drawing 3 (c), and it becomes smaller than the case where it is shown in drawing 10 .
[0019]
[Effect of the Invention] Since the transfer characteristic of a D/A converter was set as the transfer characteristic from which the oscillation frequency of a voltage controlled oscillator changes to a linear to temperature compensation data according to this invention as explained above, it is effective in frequency change of becoming fixed irrespective of the height of a compensation electrical potential difference, when temperature compensation data do **1** change of by LSB, and the tolerance of the frequency temperature characteristic becoming small. Therefore, further, in order to raise temperature compensation precision, it is effective in the ability to respond by making the number of bits of a D/A converter increase.

[Translation done.]

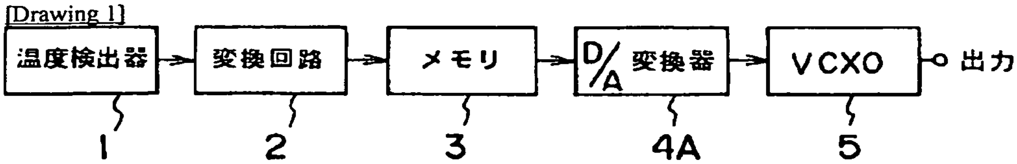
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of one example of this invention.
[Drawing 2] It is the block diagram showing the configuration of the D/A converter in one example of this invention.
[Drawing 3] It is the ** type property Fig. with which explanation of an operation of one example of this invention is presented.
[Drawing 4] It is the block diagram showing the configuration of other examples of this invention.
[Drawing 5] It is the block diagram showing the configuration of the conventional example.
[Drawing 6] It is the transfer characteristic Fig. of D/A.
[Drawing 7] It is the property Fig. of electrical-potential-difference pair variable capacitance diode.
[Drawing 8] It is the load-carrying capacity pair oscillation frequency-characteristics Fig. of a quartz resonator.
[Drawing 9] It is the frequency temperature profile of the AT cut quartz resonator which makes a cut angle a parameter.
[Drawing 10] It is the ** type property Fig. with which explanation of an operation of the conventional example is presented.
[Description of Notations]
1 Thermometric Element
2 Conversion Circuit
3 Memory
4A D/A converter
5 Voltage Controlled Oscillator
6 Equalizer

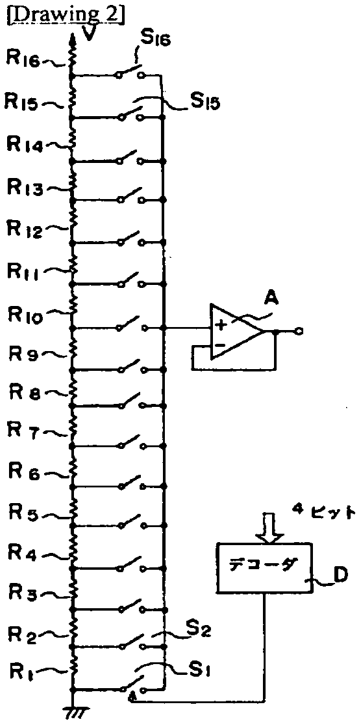
[Translation done.]

DRAWINGS

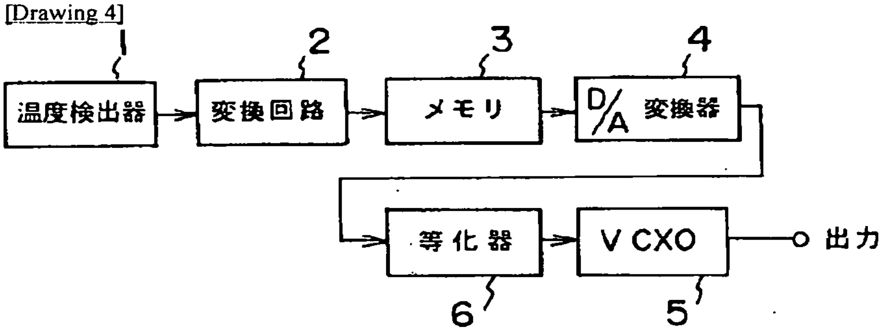
[Drawing 1]



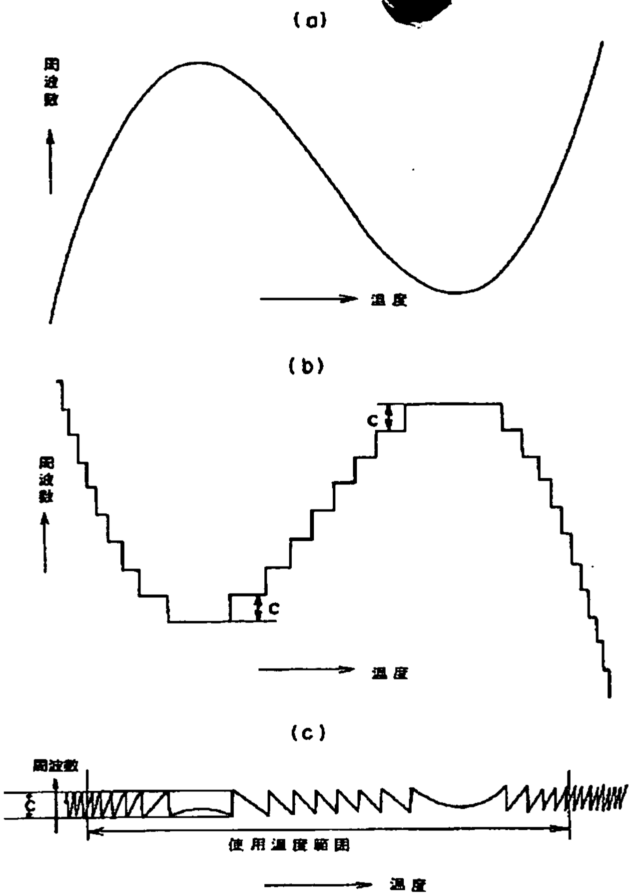
[Drawing 2]



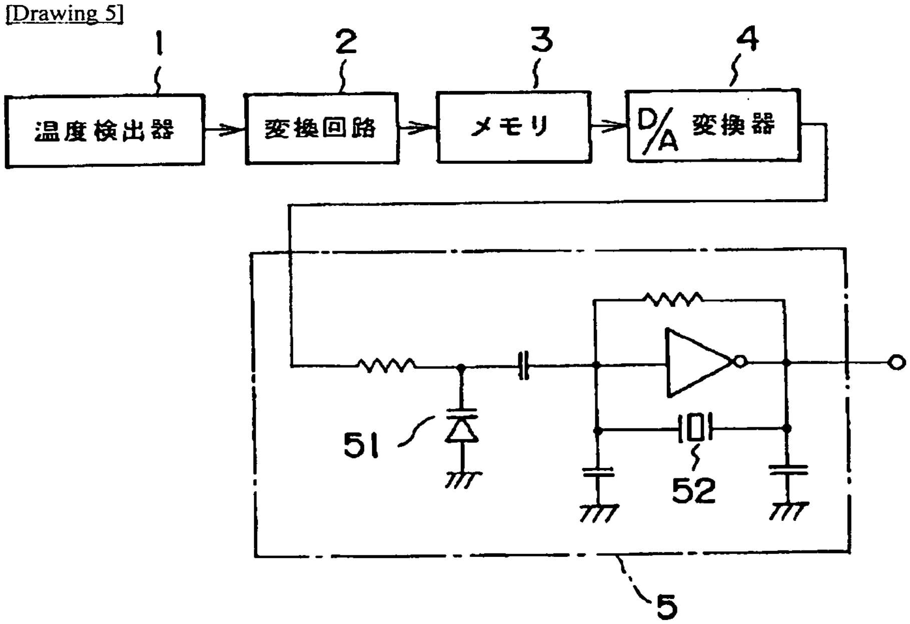
[Drawing 4]



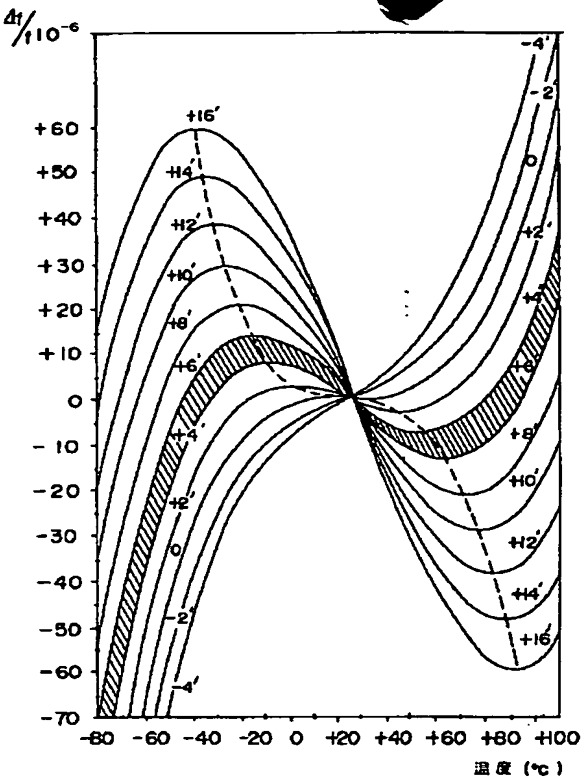
[Drawing 3]



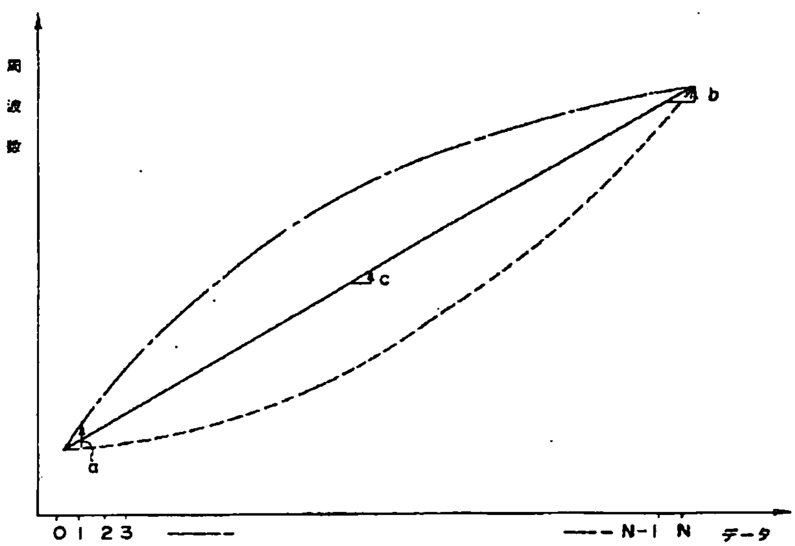
[Drawing 5]



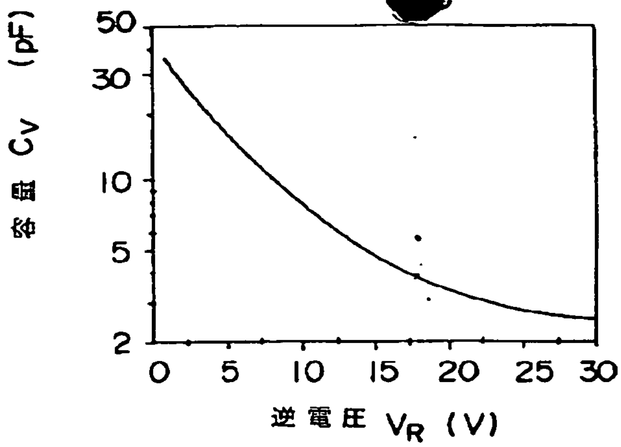
[Drawing 9]



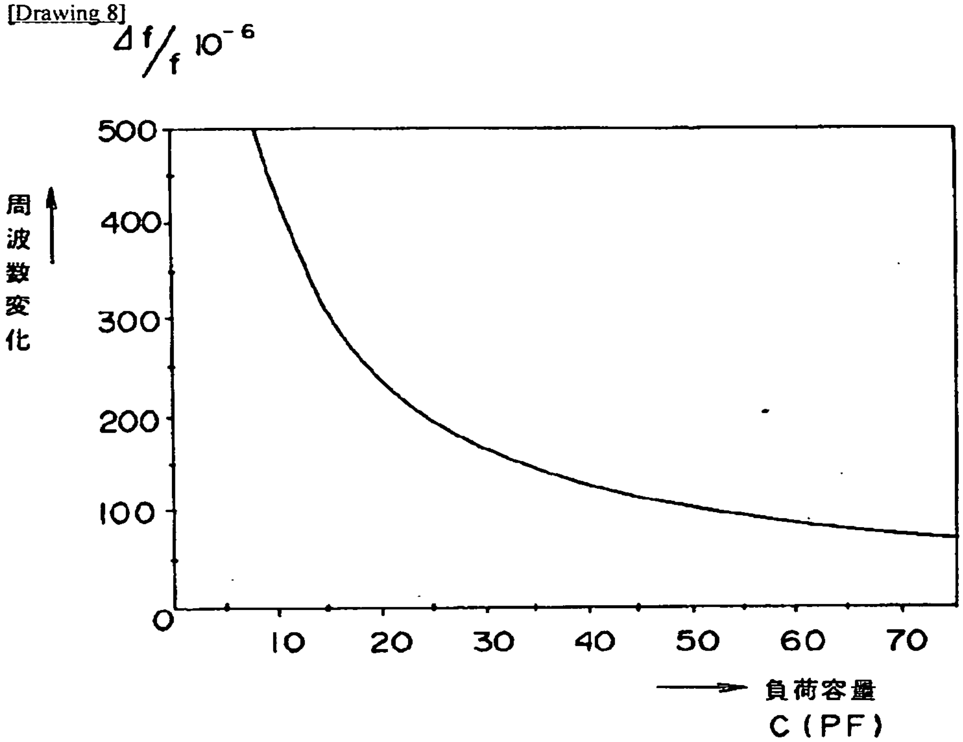
[Drawing 6]



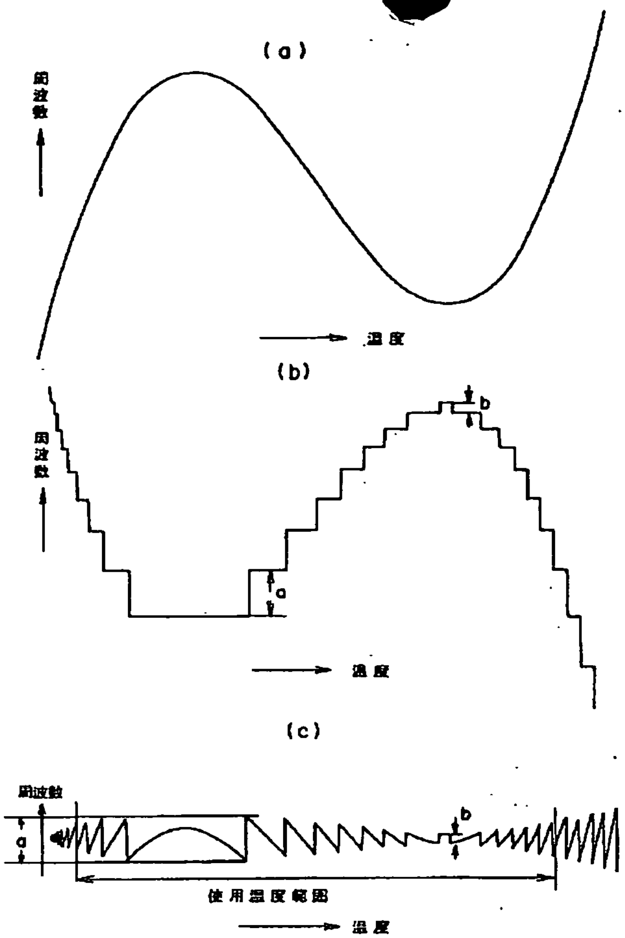
[Drawing 7]



[Drawing 8]



[Drawing 10]



[Translation done.]